Assessing graduating dental students' competencies: the impact of classroom, clinic and externships learning experiences

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Abstract

Objectives: The present study assessed recent dental graduates' educational experiences with regard to competency development in different learning contexts and preparedness for independent professional performance.

Methods: The present study employed a questionnaire examining University of Manitoba graduating dental students' confidence and perceived importance of 47 competencies expected by the ACFD/CDA by requiring students to rate each competency on a five-point Likert scale. In addition, contribution of each of the three learning environments (classroom, clinic, and externship) towards competency development was assessed.

Results: Recent graduates reported most confidence in areas of basic clinical procedures involving radiographic, pharmacologic and caries management, with least confidence in implantology, orofacial pain, trauma and surgical management. Most importance was attributed to interpersonal-communication and basic clinical skills, with least importance in scientific research, implantology and prosthetic laboratory aspects. Overall, graduates felt that clinical setting contributed the most to competency development, followed by classroom and then externship contexts.

Conclusion: Graduating students' professional preparedness can reflect the quality of dental programme. However, the amount of importance that graduates place on each competency might impact their confidence in the associated competencies and vice versa. In addition, learning settings must be effectively utilised for particular competencies' development.

Introduction

As a result of a recent national *ad hoc* advisory committee, consisting of members from the National Dental Examining board (NDEB), the Canadian Dental Association's Council on Education, the Association of Canadian Faculties of Dentistry (ACFD) and the Commission on Dental Accreditation of Canada (CDAC), existing competencies for a beginning dental practitioner in Canada have been revised (1). This set of 47 competencies has been successfully used by the NDEB to

develop national certification examinations by Canadian Faculties of dentistry to develop and monitor curriculum and by the CDAC for accreditation purposes. Current literature states that dental undergraduate education is often perceived as preparing graduates that 'are not as good as they used to be', a finding largely based on anecdotal evidence (2). Studies that focus on identifying the various factors that yield a successful learning experience for dental students are important. These include surveys directed at graduates recounting their learning experiences and identifying items perceived as most useful and items

requiring further refinement. Critical to measuring the effectiveness of the learning process is an evaluation of recent graduating students' perceptions of confidence in each of the competencies supporting a practicing dentist. For the most part, a dental student's education is based on a competency-based education (CBE), which has three major foci. First, to determine the knowledge, skills, attitudes and values required of a beginning dental practitioner often referred to as defining the competencies. Second, to develop the curricular structure that helps undergraduate students acquire the necessary learning experiences leading to competency. Third, to evaluate the outcomes of the educational process so that faculty 'know' if students have attained the competencies. Added to these foci is an evaluation of the extent to which each of the learning environments – the classroom, the clinic and the community service experience – successfully prepared dental graduates for each of the important competencies required of practicing dentists. The present study is the first initiative of a larger project that focused on the assessment of dental programmes by various stakeholders, including new students, current students, graduates, alumni and the dentist community.

Literature review

Of importance to the present study are current findings on assessment of undergraduate dental curriculum by graduating students, the type of information collected from graduating dental students, the extent to which each of the learning contexts have been included in the assessment of student learning and the methodology of current outcome assessments. Each of these areas is discussed below. The critical elements are highlighted, caveats identified and solutions proposed.

Whilst studies assessing present undergraduate dental curriculum have relied on the opinions of various stakeholders, such as final-year students (3), recently qualified graduates (4–10), qualified or registered dentists (10–14), alumni (15–18) and Deans or Departmental Representatives of Dental Schools (19), research on graduating dental students immediately following their last classes is less prevalent. Where research has focused on the latter, it is not clear that the assessment was conducted immediately after the last class. In many cases, research on graduating dental students could represent any time in the final year to the first day of practicing dentistry (3, 12, 13). Timing of the survey can make a substantial difference on the outcome (20) and hence needs to be standardised or at least consistently administered to ensure that the influence of timing is controlled. Moreover, outcome assessments based on time between training and assessment can create variability of outcomes as a result of the time passed between treatment and assessment. In order to control for the variability in time duration between student learning and the assessment of learning, the present study focused only on assessing student learning immediately following the completion of all course work with final course grades and completion of the national board examinations, providing the students with an indication of how well they did in the programme.

Many of the current studies have relied exclusively on student opinions, focusing more on student comments and less on standardised instruments assessing competencies of the dental programme (6, 9, 10, 14, 21, 22). Although helpful, a more informative method would focus on the self-estimated importance of the various competencies (23) and a measure of self-rated confidence on each of the competencies required of practicing dentists (17, 21, 24, 25).

Also important to the assessment of the formal dental training is the extent to which each of the various learning contexts has been conducive in improving each of the competencies required of a practicing dentist. Most research on programme outcome assessment identifies an array of programme strengths, such as provision of crowns, veneers and bridgework (5, 18) and programme challenges such as the identification of certain imperfections in dental education and insufficient training in surgical extractions (5–8, 16, 22, 26). Also of importance is the spectrum of findings reported, including a general overview of respondents attributing their undergraduate education as having prepared them reasonably well for general practice (14, 15, 22, 27) to very specific educational topics such as treating simple orthodontic cases with removable appliances or insufficient emphasis on ethics and legal matters (5, 13, 17). Although each of these findings is helpful in directing strategic planning of future dental programs, more effective would be an analysis of the extent to which each of the learning contexts (i.e. classroom, clinic and the community service experience) enhanced the learning of each of the competencies required by a practicing dentist (28, 29). At present, it is somewhat challenging to determine which of the various learning contexts is directly responsible for each of the learning outcomes reported. In order to address this limitation, the present study assessed the extent to which each of the competencies is directly influenced by each of the learning contexts. This novel approach provided a refined assessment of the extent to which a student learns each competency as a result of the learning context.

In many cases, the outcomes measured cannot easily be identified with specific learning environments. Although associations between competency and learning context can be speculated (i.e. training in surgical extractions might be more fitting to the clinic), in most cases, there is much overlap between one competency and the various learning contexts. In order to address this caveat, the present study assessed the relationship of the learning of a particular competency to a particular learning environment; each competency was assessed in each learning context. For example, the competency concerning the provision of crowns may be addressed more in clinic, than in the classroom and the practicum. Few, if any studies, have compared a graduate's experience across all three of these important teaching contexts, providing less than a comprehensive picture of the graduate's overall learning experience.

Most of the studies identified in the literature have relied on postal questionnaires (4–6, 13, 15, 17, 30–32). Most of these were challenged with less than ideal response rates. For instance, only one-third were returned (24). One other format reported in the literature involves an online questionnaire, which too had challenges with response rates (33). In order to increase a high-response rate and to increase the importance of the present study, the assessment occurred in a face-to-face format following completion of all course work and the national board examinations.

Methodology

The Graduating Dental Students Competency Assessment (CDSCA) questionnaire was created to include demographics (i.e. gender, age, both parent's occupations, GPA in final semester and student awards received) and the competencies determined as critical for practicing dentists by academic deans representing Dentistry Faculties and schools across Canada. Quantitative was gathered (33). Quantitative data took the form of rating the 47 CDAC competencies on a five-point Likert scale: the perceived importance of each competency (e.g. '1 = not at all important' to '5 = very important'); and perceived confidence in each competency (e.g. '1 = not at all confident' to '5 = very confident') Overall preparedness for practice was also rated from 1 (not at all prepared) to 5 (very prepared) (17). The extent to which each of the three learning contexts had an influence on each of the competencies was rated on a five-point Likert scale: 1 (no influence) to 5 (great influence). For instance, 'To what extent did your classroom experience prepare you for this?' The same question was repeated for each of the other two learning contexts: clinic and externship.

Two of the 47 competencies were broken down into more specific questions. 'Manage partially and completely edentulous patients with prosthodontic needs including the provision of fixed, removable, and implant prostheses', which was divided into three separate questions, representing each of the three types of prostheses – fixed, removable and implant. 'Manage dental caries, tooth defects and aesthetics problems and when restoration is warranted, using direct techniques such as amalgams/composites and indirect techniques such as crowns, inlays, veneers to restore teeth to form and function that minimise loss of tooth material and preserve tooth vitality' was split into two questions focusing on the direct and indirect techniques. This resulted in creating a total of 50 competencies for the present study.

Procedure

Ethical approval was granted for this study for each of the 5 years that the data were collected. A total of 97 graduating dental students at the University of Manitoba Faculty of Dentistry representing 55.43% of the total graduating population over the last 5 years completed the CDSCA questionnaire as part of their exit interview following completion of all their course work and the national board examinations, 19 in 2005 (59.38%), 17 in 2006 (48.57%), 17 in 2007 (48.57%), 26 in 2008 (74.29%) and 18 in 2009 (51.43%).

Results

Demographics

The five consecutive graduating classes of Dentistry students from University of Manitoba Faculty of Dentistry consisted of 175 graduates. Of these graduates, 97 (39 female and 57 male)[1] completed the survey (response rate = 55.43%). The mean age of the respondents was 27.71 years (SD = 3.87; with a range of 23—42). Twenty-four respondents (25.30%) claimed English as their second language, and 12 (12.80%) were enrolled in the International Dentistry Degree Program.

Competencies

A series of assessments that provide an indication of the dentistry programme's impact on student learning is seen in Table 1 and is based on the current 47 CDAC global competencies (see http://www.acfd.ca/en/publications/index.html for more details). Of significance to this study, was to capture the perceived importance of each of the global competencies to graduating students, the extent to which the student felt confident with each of the competencies and the extent to which the various learning contexts in the dental programme prepared students for each competency.

As seen in the second column from the right in Table 1, all competencies are thought to be important to graduating students and all score well above (3.76 or higher) the median (3.00) of the five-point Likert scale. This is a strong affirmation of the importance of the current CDAC global competencies for beginning dental practitioners. The programme demonstrates high perceptions within the students that the current dental programmes over a period of 5 years is eliciting the significance of the competencies as important for dentistry.

Self-rated confidence for each competency

As seen in the fourth column from the right in Table 1, graduating dental students are fairly confident in most of the competencies. Sixteen (32%) of the competencies score above a mean of 4.00 over all 5 years in terms of confidence, an additional 24 (48%) above 3.50 and 6 (12%) above 3.00. This is another strong affirmation of the current training practices of the programme. Only four (8%) competencies (e.g. 'manage surgical procedures related to oral soft and hard tissues and their complications', 'manage patients with orofacial pain and/or dysfunction', 'manage trauma to the orofacial complex', and 'manage partially and completely edentulous patients with prosthodontic needs including the provision of implant prostheses') fell below the midpoint of the scale (3.00).

Relationship between importance and perceived confidence for each competency

As seen in Table 1, far right column, all correlations between the importance and confidence ratings for each of the competencies were statistically significant, one at the $P < 0.05$ level and the remaining 49 at $P < 0.01$ level. This demonstrates that what students perceived as important is also correlated with their ratings of confidence. The correlation coefficients ranged in value from 0.217 to 0.888.

Difference between importance and perceived confidence for each competency

Another creative method in evaluating the impact of a dental programme is the extent to which a student perceives a competency as very important, yet has a low self-confidence score in

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[1] 1 participant from 2007 chose not to indicate his/her gender.

TABLE 1. Graduating students' perception of importance, confidence and the extent to which the classroom, clinic and externship environments impacted learning of the CDAC competencies and correlation coefficients for student ratings of importance with confidence on the same competencies

	Importance Mean	STD	Confidence Mean	STD	Classroom Mean	STD	Clinic Mean	STD	Externship Mean	STD	Correlation Coefficients
Perform a clinical examination.	4.77	0.67	4.26	0.81	3.15	1.10	4.36	0.80	3.60	1.09	0.612**
Interpret the findings from a patients' history, clinical examination, radiographic examination and from other diagnostic tests and procedures.	4.74	0.67	4.00	0.77	3.49	0.95	4.09	0.89	3.32	1.10	0.595**
Communicate effectively with patients, parents or guardians, staff, peers, other health professionals and the public.	4.71	0.72	4.28	0.80	2.86	1.16	3.99	0.97	3.66	1.18	0.703**
Identify the patients' chief concern/complaint and obtain the associated history.	4.71	0.70	4.40	0.80	3.28	1.10	4.37	0.77	3.73	1.14	0.686**
Achieve local anaesthesia for dental procedures and manage related complications.	4.68	0.95	4.18	1.04	3.10	1.18	4.15	1.05	3.41	1.25	0.824**
Demonstrate professional behaviour that is ethical, supercedes self-interest, strives for excellence is committed to continued professional development and is accountable to individual patients, society and the profession.	4.68	0.72	4.35	0.83	3.32	1.30	3.68	1.26	3.13	1.44	0.686**
Perform a radiographic examination.	4.67	0.71	4.34	0.78	3.67	1.00	4.24	0.95	3.40	1.09	0.727**
Develop treatment options based on the evaluation of all relevant data.	4.63	0.72	4.01	0.84	3.31	0.97	4.04	0.95	3.13	1.22	0.535**
Manage dental caries, tooth defects and aesthetics problems and when restoration is warranted, using direct techniques such as amalgams/composites, to restore teeth to form and function that minimise loss of tooth material and preserve tooth vitality.	4.63	1.05	4.25	1.08	3.35	1.21	4.23	1.09	3.49	1.29	0.888**
Maintain accurate and complete patient records in a confidential manner.	4.61	0.73	4.26	0.85	3.15	1.20	4.15	0.93	3.44	1.17	0.604**
Develop a problem list and establish diagnosis.	4.59	0.75	3.96	0.81	3.56	1.00	3.84	0.86	3.18	1.08	0.567**
Manage dental emergencies.	4.59	0.98	3.57	1.06	2.87	1.11	3.41	1.12	3.14	1.23	0.631**
Differentiate between normal and abnormal hard and soft tissues of the maxillofacial complex.	4.58	0.75	3.99	0.80	3.80	0.96	3.77	0.98	3.22	1.18	0.484**
Manage dental caries, tooth defects and aesthetics problems and when restoration is warranted, using indirect techniques such as crowns, inlays, veneers to restore teeth to form and function that minimise loss of tooth material and preserve tooth vital.	4.57	1.06	3.95	1.08	3.28	1.18	4.05	1.09	2.60	1.42	0.628**
Discuss the findings, diagnosis, aetiology, risks, benefits and prognoses of the treatment options, with a view to patient participation in oral health management.	4.57	0.77	3.92	0.81	3.37	0.97	3.80	0.94	3.03	1.20	0.798**
Develop an appropriate comprehensive, prioritised and sequenced treatment plan.	4.54	0.87	3.99	0.95	3.22	1.13	4.01	1.03	2.98	1.27	0.621**
Apply the basic principles of practice administration, financial and personnel management to a dental practice.	4.53	0.77	3.43	0.97	3.46	1.19	2.31	1.24	1.78	1.17	0.365**
Prescribe and obtain the required diagnostic tests considering their risks and benefits.	4.51	0.74	3.92	0.82	3.51	0.91	3.67	1.00	2.96	1.14	0.792**

TABLE 1. (Continued)

	Importance Mean	STD	Confidence Mean	STD	Classroom Mean	STD	Clinic Mean	STD	Externship Mean	STD	Correlation Coefficients
Obtain informed consent including the patients' written acceptance of the treatment plan and any modifications.	4.51	1.01	4.07	1.03	3.22	1.24	3.93	1.12	2.80	1.27	0.594**
Apply accepted principles of ethics and jurisprudence to maintain standards and advance knowledge and skills.	4.49	0.81	3.99	0.86	3.60	1.26	3.14	1.33	2.45	1.37	0.534**
Recognise and manage the anxious or fearful dental patient.	4.49	0.77	3.72	0.92	2.73	1.00	3.56	1.21	3.14	1.26	0.429**
Present and discuss the sequence of treatment, estimated fees, payment arrangements, the time requirements and the patients' responsibilities for treatment.	4.47	0.82	4.05	0.93	3.01	1.22	3.96	1.09	2.98	1.24	0.719**
Manage conditions and pathology of the pulp and provide endodontic treatment when indicated.	4.47	1.11	3.67	1.13	3.27	1.17	3.72	1.21	2.27	1.27	0.614**
Prevent the transmission of infectious diseases by following current infection control guidelines.	4.46	0.85	4.31	0.84	3.60	1.15	4.00	0.99	3.17	1.26	0.688**
Modify treatment plan as required during the course of treatment.	4.44	1.03	4.05	1.02	2.85	1.16	4.00	1.08	3.02	1.22	0.748**
Recognise and manage systemic emergencies that may occur in dental practice.	4.44	1.09	3.03	1.14	3.05	1.13	2.76	1.20	2.35	1.16	0.598**
Manage partially and completely edentulous patients with prosthodontic needs including the provision of fixed prostheses.	4.43	1.10	3.78	1.14	3.31	1.18	3.89	1.16	2.24	1.36	0.829**
Determine the level of expertise required for treatment and formulate a written request for a consultation and/or referral when appropriate.	4.43	0.79	3.90	0.80	3.24	1.01	3.72	0.99	2.94	1.11	0.554**
Assess the risk, extent and activity of caries and recommend appropriate non-surgical and surgical therapy.	4.43	1.11	4.08	1.09	3.42	1.23	3.95	1.16	3.21	1.30	0.699**
Design a dental prosthesis or appliance, write a laboratory prescription and evaluate laboratory products.	4.43	0.81	3.86	0.90	3.10	1.20	3.81	1.04	2.24	1.42	0.519**
Determine the indications and contraindications for use of drugs, drug dosages and routes of administration for drugs and write prescriptions for drugs used in dentistry.	4.43	1.09	3.51	1.10	3.51	1.17	3.23	1.20	2.82	1.22	0.750**
Provide therapies for the prevention of oral disease and injury.	4.36	1.02	3.69	1.10	3.27	1.14	3.53	1.08	2.91	1.13	0.664**
Recognise the determinants of oral health in individuals and populations and the role of dentists in health promotion, including the disadvantaged.	4.33	0.78	3.93	0.70	3.23	0.91	3.81	0.82	3.76	1.14	0.374**
Manage partially and completely edentulous patients with prosthodontic needs including the provision of removable prostheses.	4.28	1.21	3.51	1.18	3.18	1.14	3.67	1.26	2.37	1.31	0.711**
Manage conditions and diseases of the periodontium, provide periodontal treatment when indicated and monitor treatment outcomes.	4.27	1.16	3.74	1.15	3.43	1.17	3.62	1.17	2.78	1.26	0.788**
Obtain and interpret a medical, dental and psychosocial history, including a review of systems as necessary and evaluate physical or psychosocial conditions that may affect dental management.	4.26	0.83	3.68	0.96	3.26	0.97	3.59	1.09	3.35	1.12	0.555**

TABLE 1. (Continued)

	Importance Mean	STD	Confidence Mean	STD	Classroom Mean	STD	Clinic Mean	STD	Externship Mean	STD	Correlation Coefficients
Provide education regarding the risks and prevention of oral disease and injury to the encourage adoption of healthy behaviours.	4.25	1.04	3.78	1.06	3.30	1.12	3.51	1.07	2.93	1.18	0.697**
Recognise the relationship between general and oral health.	4.24	0.74	3.76	0.79	3.44	0.93	3.58	0.99	3.24	1.21	0.371**
Recognise signs of abuse/neglect and make appropriate reports.	4.23	0.93	3.20	0.94	2.98	0.85	2.46	1.10	2.42	1.19	0.454**
Make records for use in the laboratory fabrication of dental prostheses and appliances.	4.23	0.99	4.12	0.89	3.05	1.20	4.11	0.95	2.46	1.49	0.513**
Assess patient risk (including but not limited to diet and tobacco use) for oral disease or injuries.	4.22	0.85	3.79	0.96	3.51	0.98	3.43	1.03	3.05	1.16	0.632**
Recognise and manage functional and non-functional occlusion.	4.21	0.93	3.59	1.01	3.22	1.05	3.49	1.10	2.38	1.31	0.573**
Manage partially and completely edentulous patients with prosthodontic needs including the provision of implant prostheses.	4.15	1.05	2.24	1.13	2.13	0.91	1.99	1.19	1.37	0.78	0.217*
Manage patients with orofacial pain and/or dysfunction.	4.12	1.16	2.92	1.14	2.96	1.10	2.71	1.09	2.18	1.21	0.581**
Manage surgical procedures related to oral soft and hard tissues and their complications.	4.09	1.14	2.99	1.12	2.88	1.04	2.79	1.20	2.44	1.26	0.645**
Recognise and institute procedures to prevent occupational hazards related to the profession of dentistry.	4.06	1.14	3.46	1.12	2.85	1.10	3.00	1.18	2.46	1.18	0.635**
Manage trauma to the orofacial complex.	4.04	1.22	2.77	1.14	2.76	1.05	2.40	1.08	2.06	1.18	0.574**
Select and where indicated prescribe appropriate biomaterials for patient treatment.	3.93	1.18	3.37	1.21	3.05	1.09	3.14	1.14	2.45	1.30	0.682**
Manage abnormalities of orofacial growth and developmental and treat minor orthodontic problems.	3.89	1.25	3.11	1.26	3.02	1.21	3.08	1.39	1.93	1.30	0.658**
Evaluate the scientific literature and justify management recommendations based on the level of evidence available.	3.76	0.99	3.67	0.93	3.66	0.98	2.79	1.06	2.40	1.19	0.546**
Total means	4.40		3.77		3.22		3.57		2.84		

*$P < 0.05$; **$P < 0.01$.

the area. This would suggest the training for this particular competency has not adequately prepared the graduating student, especially when the class average demonstrates large discrepancies (e.g. difference score of 1.00 or higher) between what is perceived as important and students' confidence. When evaluating the competency differences between the mean for importance (see Table 1 column 2) and the mean for confidence (see Table 1 column 4), a total of eight competencies indicate that perceived importance was substantially greater ($P < 0.05$), than perceived confidence (a difference score of 1.00—1.90). These included: 'Manage partially and completely edentulous patients with…implant prostheses'. 'Recognize and manage systemic emergencies..'. 'Manage trauma to the orofacial complex'. 'Manage patients with orofacial pain and/or dysfunction'. 'Manage surgical procedures related to oral soft and hard tissues and their complications'. 'Apply the basic principles of practice administration, financial and personnel management to a dental practice'. 'Recognize signs of abuse/neglect and make appropriate reports'. 'Manage dental emergencies'. These eight competencies demonstrate that students perceive that the level of importance is far greater than their current perception of confidence in performing these competencies. These findings are significant in flagging the need for curriculum management in the delivery of course material that would strengthen students' confidence in each of these competencies.

Second, 28 competencies fall between a difference score of 1.00—0.50, an additional 15 are in the range of 0.50—0.10. Each of these difference scores provides additional evidence to the strength of the dental programme as seen in the level of importance and confidence perceived by students. However, what is not clearly known is how each of the three learning environments influences students' learning of these competencies.

Competency preparation by learning context: classroom, clinic and externship

In order to gain a better perspective as to how each of the three learning environments influence learning of each of the competencies, students were asked to self-rate the level of preparation for each of the competencies via classroom, clinic and externship contexts. The sixth column in Table 1 demonstrates the levels that classroom training prepared students in each of the competencies. A total of 9 (18%) competencies score over 3.50, an additional 31 (62%) competencies score between 3.00 and 3.50, 9 (18%) score between 2.50 and 3.00 and only 1 (2%) scored significantly lower than all other competencies at 2.13. These findings indicate that the majority (40% or 80% above the median 3.00) of the competencies are supported in the classroom learning environment. But how do the results related to the classroom compare to those found in the other two learning environments, namely the clinic and the externship?

Column eight in Table 1 demonstrates the levels that clinic training prepared students to carry out each of the competencies. A total of 11 (22%) competencies score over 4.00, an additional 23 (46%) competencies score between 4.00 and 3.50, 8 (16%) score between 3.50 and 3.00, 4 (8%) score between 3.00 and 2.50, 3 (6%) score between 2.50 and 2.00, and only 1

(2%) scored at 1.99. These findings indicate that the majority (42% or 84% above the median 3.00) of the competencies are supported in the clinic learning environment. How do the clinic results compare to those found in the externship learning environment?

Column 10 in Table 1 demonstrates the levels that externship training prepared students to carry out each of the competencies. A total of 4 (8%) competencies score 4.00—3.50, 18 (36%) score between 3.50 and 3.00, 10 (20%) score between 3.00 and 2.50, 15 (30%) score between 2.50 and 2.00, and only 3 (6%) scored below 2.00. These findings indicate that the majority (32% or 64% above the median 3.00) of the competencies are supported in the externship learning environment. Although each of these learning environments is perceived by students to prepare them differently on each competency, what are these differences amongst these three learning environments?

Based on the findings from Table 1, the clinic produces the highest perceptions of preparedness with 42 competencies above the mid point of the scale (above 3.00) and a mean across all competencies as 3.57, followed by the classroom with 40 competencies above the mid point of the scale and a mean across all competencies as 3.22, and externship with 22 competencies above the mid point of the scale and a mean across all competencies as 2.84.

Of further interest are the scoring patterns of each competency across each of the three learning environments. The first pattern includes 18 competencies that are perceived as scoring well above the midpoint of the scale (above 3.00) across each of the three learning contexts – competencies well-taught from three different learning contexts. These include: based on graduate's perceptions, each of the three learning contexts were instrumental in preparing them for these competencies. 'Recognize the determinants of oral health..'. 'Identify the patients' chief concern/complaint..'. 'Perform a clinical examination'. 'Manage dental caries..'. 'Maintain accurate and complete patient records..'. 'Achieve local anesthesia..'. 'Perform a radiographic examination'. 'Obtain and interpret a medical, dental, and psychosocial history..'. 'Interpret the findings from a patients' history..'. 'Recognize the relationship between general and oral health'. 'Differentiate between normal and abnormal hard and soft tissues of the maxillofacial complex'. 'Assess the risk, extent and activity of caries and recommend appropriate non-surgical and surgical therapy'. 'Develop a problem list and establish diagnosis'. 'Prevent the transmission of infectious diseases..'. 'Develop treatment options based on the evaluation of all relevant data'. 'Demonstrate professional behaviour..'. 'Assess patient risk..'. 'Discuss the findings, diagnosis, etiology, risks, benefits and prognoses of the treatment options..'.

The second pattern includes 23 competencies that are perceived as scoring poorly or below the midpoint of the scale (above 3.00) in at least one, but higher in the other two learning contexts – compensated competencies by two learning contexts. A total of 19 were compensated by a combination of the classroom and the clinic and include: 'Develop an appropriate comprehensive, prioritized and sequenced treatment plan'. 'Present and discuss the sequence of treatment, estimated fees, payment arrangements, the time requirements and the patients' responsibilities for treatment'. 'Prescribe and obtain the

required diagnostic tests considering their risks and benefits'. 'Determine the level of expertise required for treatment..'. 'Provide education regarding the risks and prevention..'. 'Provide therapies for the prevention of oral disease and injury'. 'Determine the indications and contraindications for use of drugs..'. 'Obtain informed consent..'. 'Manage conditions and diseases of the periodontium..'. 'Manage dental caries, tooth defects and esthetics problems..'. 'Make records for use in the laboratory fabrication of dental prostheses and appliances'. 'Select and where indicated prescribe appropriate biomaterials..'. 'Apply accepted principles of ethics and jurisprudence..'. 'Recognize and manage functional and non-functional occlusion'. 'Manage partially and completely edentulous patients with…removable prostheses'. 'Manage conditions and pathology of the pulp and provide endodontic treatment when indicated'. 'Manage partially and completely edentulous patients with…fixed prostheses'. 'Design a dental prosthesis or appliance, write a laboratory prescription and evaluate laboratory products'. 'Manage abnormalities of orofacial growth..'.

An additional four competencies were compensated by the clinic and the externship and include: 'Communicate effectively with patients, parents or guardians, staff, peers, other health professionals and the public'. 'Recognize and manage the anxious or fearful dental patient'. 'Manage dental emergencies'. 'Modify treatment plan as required during the course of treatment'. For each of these competencies, two learning contexts tend to compensate for that of the third. There were no competencies that were compensated by a combination of the classroom and the externship learning contexts.

The third pattern includes four competencies that are perceived as scoring below the midpoint of the scale (above 3.00) across two, the clinic and externship learning contexts, but higher in one learning context, the classroom – compensated competencies by one learning context. These include: 'Recognize and institute procedures to prevent occupational hazards…' 'Evaluate the scientific literature and justify management recommendations..'. 'Recognize and manage systemic emergencies..'. 'Apply the basic principles of practice administration..'. At least on learning context, the classroom seems to have taught students well. These make sense as the skill set for each of these competencies is best taught in the classroom.

The fourth pattern includes competencies that are perceived as scoring poorly or below the midpoint of the scale (above 3.00) across all learning contexts – requiring immediate attention competencies. These included: 'Manage surgical procedures related to oral soft and hard tissues..'. 'Recognize signs of abuse/neglect..'. 'Manage patients with orofacial pain..'. 'Manage trauma to the orofacial complex'. 'Manage partially and completely edentulous patients with…implant prostheses'. Each of these latter four require immediate attention by the curriculum committee for improvement within the programme.

Discussion

The assessment of the effectiveness of the curriculum is critical to ensure the achievement of programme goals (34). The curriculum assessment serves as a necessary assurance to the students, to the profession and to the public at large that the students graduating from the specific curriculum are well qualified to embrace oral health care. The various assessment methods for curriculum evaluation involve qualitative as well as quantitative tools. The former include curriculum guidelines, competency documents, discussion and focus groups, and teaching portfolios. The latter encompass competency examinations, board examinations, oral comprehensive examinations, clinical productivity, and student and alumni surveys. In general, the surveys formatted as questionnaires are often used as a curriculum assessment tool due to a rapid generation of information at low cost and with least involvement of the staff (34). In particular, student surveys of graduating students are often used to assess the quality of the Faculty and school services, future career plans of the graduates and teaching time distribution in different areas of undergraduate education.

However, research on graduating dental students immediately following their last classes is less prevalent. Where research has focused on the latter, it is not clear whether the assessment was conducted immediately after the last class. In many cases, research on graduating dental students could represent any time in the final year to the first day of practicing dentistry (3, 12, 13). Outcome assessments based on time between training and assessment can create variability of outcomes as a result of the time passed between treatment and assessment. In addition, if the length of time between the end of the university training and data gathering is long, it becomes more challenging to differentiate the effects of the curriculum from those of the further experience (34). In order to control for the variability in time duration between student learning and the assessment of learning, the present study focused only on assessing graduating students' learning immediately following the completion of all course work.

There are many similarities to the previous studies conducted with the recent graduates; however, certain findings shed light on unique and particular issues pertaining to the competency-based curriculum adopted at the University of Manitoba Faculty of Dentistry 1999. The response rate for this study was 55.43%, which is slightly lower than the response rates of previous studies of graduating students in University of Toronto (72%) (35) and those from UK dental schools (70%) (36).

Self-rated importance of competencies

Regarding the importance of each competency towards the establishment of a successful dental practice, the recent graduates felt that the performance of a clinical exam, obtaining of informed consent, knowledge of appropriate administration and choice of pharmaceuticals, professional and ethical behaviour, and effective interpersonal communication skills were the most valued competencies. Similarly, interpersonal skills as well as clinical patient assessment were also amongst the highest rated desirable abilities by the recent graduates in the United States (37).

The graduating dental students felt that the following competencies had the least importance in their contribution to the dental career: the management of partially or completely edentulous patients with implant prosthodontics, evaluation and utilisation of the scientific literature, selection and prescription

of appropriate biomaterials, recognition of oral health determinants in various populations, and obtainment of records for the laboratory fabrication of dental prostheses. These findings are only slightly similar to the previously conducted study of recent graduates in the area of prosthetic restorations, otherwise, the participants in United States felt that specific clinical procedures associated with surgical periodontics, orthodontics and surgical endodontics were less relevant to the dental practice (37). Such differences may reflect the earlier day philosophies regarding certain fields of dentistry as well as lack of survey break down into specific competencies to be evaluated.

Self-rated confidence in competencies

With respect to the self-reported confidence in all the competencies, the graduating dental students felt most confident in managing dental caries, defects and aesthetics with direct techniques, performing a clinical exam, obtaining informed consent, appropriately administering and choosing pharmaceuticals, behaving with professional and ethical values, and communicating in effective interpersonal manner. Similarly, graduate students from United States felt most competent in analogous areas, more specifically, in oral examination and diagnosis, operative, as well as interpersonal skills (38). The recent graduates from the Canadian dental schools (University of Toronto and Dalhousie University), Australia and Trinidad also considered themselves most prepared in the basics of the general practice such as oral diagnosis and local anaesthesia (17, 35). It is important to note that self-perceived competency does not necessarily guarantee real competence, thus it would be more correct to refer to individual's belief in his or her preparedness as 'confidence' instead (35). The value of students' expression of confidence lies in the observations that the level of confidence is likely to influence the willingness of the type of clinical tasks that one will perform after the graduation; therefore, faculty can have valuable feedback regarding the educational value of the curriculum based on self-reported confidence levels in certain competency domains (35).

The areas in which the graduating students reported the least confidence were the management of partially or completely edentulous patients with implant prosthodontics, addressing trauma to the orofacial complex, performance of surgical procedures of soft and hard oral tissues, treatment of orofacial pain and recognition of abuse and neglect. As implant procedures and maxillofacial trauma are only superficially addressed in the undergraduate curriculum, both were expected to be amongst the lowest ranked items in terms of preparedness.

Differences between importance and self-rated confidence

What is unique about the present study in relation to the existing literature is the comparison between what graduating students perceived as important and their self-rated confidence. More than likely, as a result of the role modelling of clinical instructors, the emphasis placed on these competencies during didactic and pre-clinic courses, as well as the significance viewed by the students after exposure to the clinic and the externship sites, has influenced their perception of what is considered important. Their self-rated competencies are their reflections of how confident they feel with regard to managing specific problems and/or performing clinical skills. When their ratings of importance align with their ratings of confidence, this would indicate that their training is fine. For instance, a low importance rating paralleled by a low confidence rating, such as in implant dentistry, would be fine if the graduating student was not considering doing implants in his/her practice. However, in the case where a student perceives a competency as very important, yet has a low self-confidence score in the area, the training for this particular competency has not adequately prepared the graduating student, especially when the class average demonstrates large discrepancies (e.g. difference score of 1.00 or higher) between what is perceived as important and students' confidence. These are the 'flags' that would alert curriculum managers to ensure that these specific competencies are better supported for students. A few of these were discovered in the present study and these findings are useful in the strategic planning of the curriculum management team.

Competencies learned in each of the three learning environments

Another creative method in assessing the success of a dental programme is to view the perceptions of students with regard to how well each of the learning environments prepared them for each of the competencies. In the present study, each learning environment demonstrated difference patterns of competencies that were best taught. In some cases, competencies were taught well across two learning domains, such as the classroom and the clinic or the clinic and the externship. Also interesting is the fact that some competencies that were scored low in one learning domain were compensated by being scored higher in another learning domain. Finally, competencies that score low across all three domains, with no compensation by any given learning environment, are viewed as significant and require the attention of the curriculum management team to improve, so that these competencies are supported in the learning experience of the student.

Utility of these findings in directing strategic planning for curriculum refinement

The results from the present study have been instrumental in curriculum refinement by providing critical 'flags' requiring attention. First, an implant curriculum has been developed and added to the current DMD programme to address the weakness in training students with regard to the implant competency. Second, courses dealing specifically with recognition of abuse and neglect have been provided with more resources in helping both instructors and students deal with this highly sensitive topic. Third, competencies dealing with trauma to the orofacial complex, performance of surgical procedures of soft and hard oral tissues, and treatment of orofacial pain, although taught in greater detail in graduate programmes, are also being integrated into third and fourth year DMD courses, where students are at least exposed to these topic areas, and are provided with a

chance to observe graduate students and specialists conducting these clinical procedures.

Although the current methodology is innovative in assessing curriculum impact on graduating students, there are a number of limitations that require further attention in order to ensure the utility of this methodology. Therefore, the current study will serve as a pilot study to assess areas of strength and weakness in the methodology and allow certain modifications for the future study. Ideally, these can be addressed through longitudinal data, collapsing the results of 10 or more graduating cohorts and conducting sample saturation to ensure that the potential bias resulting from missing survey respondents is controlled for (20). Even more interesting would be a longitudinal study that tracks students over their 4 years in a dental programme and compares baseline competency measures taken prior to any dental training with competency measures taken at graduation. Add to this a study of other stakeholders and their perspectives of what has been taught. Administering these innovative assessment strategies along with the replication of current findings will help provide the empirical evidence to support the development of effective models for dental education programming offered specifically for dentists at other Canadian and international academic institutions.

Acknowledgements

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